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Forecasting replacement demand by occupation and education

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Abstract

Replacement demand is an important component of the future demand for manpower often neglected in manpower demand forecasts. In particular, for characterizing the prospects for newcomers on the labour market, the manpower requirements method is not adequate as it merely focuses on employment mutations. This study builds a theoretical framework to measure the historical replacement demand distinguished by occupation and education. This framework is extended so that in addition to employment growth forecasts, forecasts can also be made of the future replacement demand for about 80 occupational classes and 50 educational groups, as we have done for the Netherlands for the period 1989–1994.

Keywords: Replacement demand; Labour market

1. Introduction

Since the 1960s, forecasts have been made of the future occupational structure of employment and have been used for manpower planning. One of the most popular planning methodologies is the manpower requirements approach developed by Parnes (1962) in the OECD's Mediterranean Regional Project [see also Psacharopoulos (1987)]. The results and usefulness of the manpower requirements approach have been evaluated by Hollister (1967), Ahamad and Blaug (1973), and Freeman (1980), among others.

For characterizing the prospects for newcomers on the labour market, however, the manpower requirements method is not adequate. Replacement demand is generally at least as important as the demand for labour owing to employment growth.[1] Replacement demand can be defined as the jobs resulting from the departures of workers that have to be filled by new workers. For example, replacement demand can be a result of permanent departures from the labour force through retirement, (temporary) withdrawals of women owing to birth and child-rearing, occupational mobility, etc. Replacement demand forecasts are not a substitute for traditional manpower forecasts but can be seen as a very important complement to the manpower forecasts of employment mutations [see, for example, US Department of Labor, Bureau of Labor Statistics 1988]. Adding these 'expansion demand' forecasts to the forecasts of replacement demand gives the number of future 'job openings'. This can be related to the number of school leavers entering the market to indicate what their labour market prospects may be.

In this article we develop a forecasting method for determining the future replacement de-

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[1] For a description of methods to forecast the occupational and educational structures of employment for the Dutch labour market, see Dekker et al. (1990) and Beekman et al. (1991), respectively.

mand for about 80 occupational classes and 50 educational types, covering the whole labour market. In Section 2, the theoretical framework for determining replacement demand is discussed. Section 3 expands this discussion to determine the future replacement demand per occupational group. Because of the unavailability of suitable individual data on the processes of mobility at a relatively low level of aggregation over the full width of the labour market, it is necessary to make some assumptions. In Section 3.1 the data employed are discussed and the method is presented. Section 3.2 uses a stylized example to measure the replacement requirements in an historical period and Section 3.3 discusses a forecasting method for the future replacement demand. Section 3.4 briefly examines the results for the Dutch labour market. The replacement demand by type of education is dealt with in Section 4, and Section 5 contains a short conclusion.

2. Replacement demand: A theoretical framework

In the labour market, mobility processes may be observed continuously. Many employees change occupations or jobs several times during their working lives. Moreover, a considerable number of people enter or leave the work force every year. Therefore, a typical career path might begin with leaving regular day-time education and entering the work force, possibly after a period of unemployment. After changing jobs several times, possibly with some periods of unemployment or a temporary withdrawal from the labour market, the worker finally leaves the work force later in life.

Figure 1 presents a transition matrix for the entire population, schematically reproducing the mobility processes described above at an aggregated level. The last column of the input–output table gives the number of workers at time $t-1$ in each of the 'jobs'[2] that have been differentiated, and also the number of unemployed and non-active people at the same time. The last row of the table gives the same figures for time t. In addition, the second to the last row of the table gives the total population influx as a result of birth and immigration, while the second to the last column gives the total outflow of population owing to death and emigration.

The inner part of the transition matrix contains the flows within the labour market. Some of these flows are indicated by the letters A to G. Flow A, for instance, indicates the number of employees that kept working in job 1 during the period $(t-1, t)$. Flows B and E represent job-to-job mobility. Flow C represents departures from employment to unemployment, while flow D represents non-availability, indicating changes such as retirement and voluntary exit from the labour market, in particular by married women. The group of unemployed who have found a job during the period $(t-1, t)$, is indicated by F. Finally, flow G refers to new positions gained by those who were not available for the labour market at time $t-1$, such as school leavers who find a job and women who re-enter the labour market.

With the aid of this framework, the concepts of expansion demand and replacement demand may be defined. The expansion demand for job i in the (historical) period $(t-1, t)$ is given by the difference in the number of workers at the two times:

$$ED_{it} = W_{it} - W_{it-1}\,, \tag{1}$$

where ED_{it} is the expansion demand in period $(t-1, t)$; W_{it} is the number of workers in job i at time t.

The replacement demand is then defined in relation to the expansion demand. Where there is a positive expansion demand (an increase in employment), the replacement demand is equal to the number of workers who leave a certain job during the period $(t-1, t)$. The vacancies that thus appear will have to be filled before there can be a rise in the total numbers employed. If the expansion demand is negative, meaning that there is a decrease in employment, not all of the vacancies created by departing employees are filled. In this case, the replacement demand is *not* equal to the total of the departures from a certain job, but rather to the number of vacancies that are actually refilled;

[2] In the practical application of this theoretical framework, occupational class and type of education replace the term 'job'.

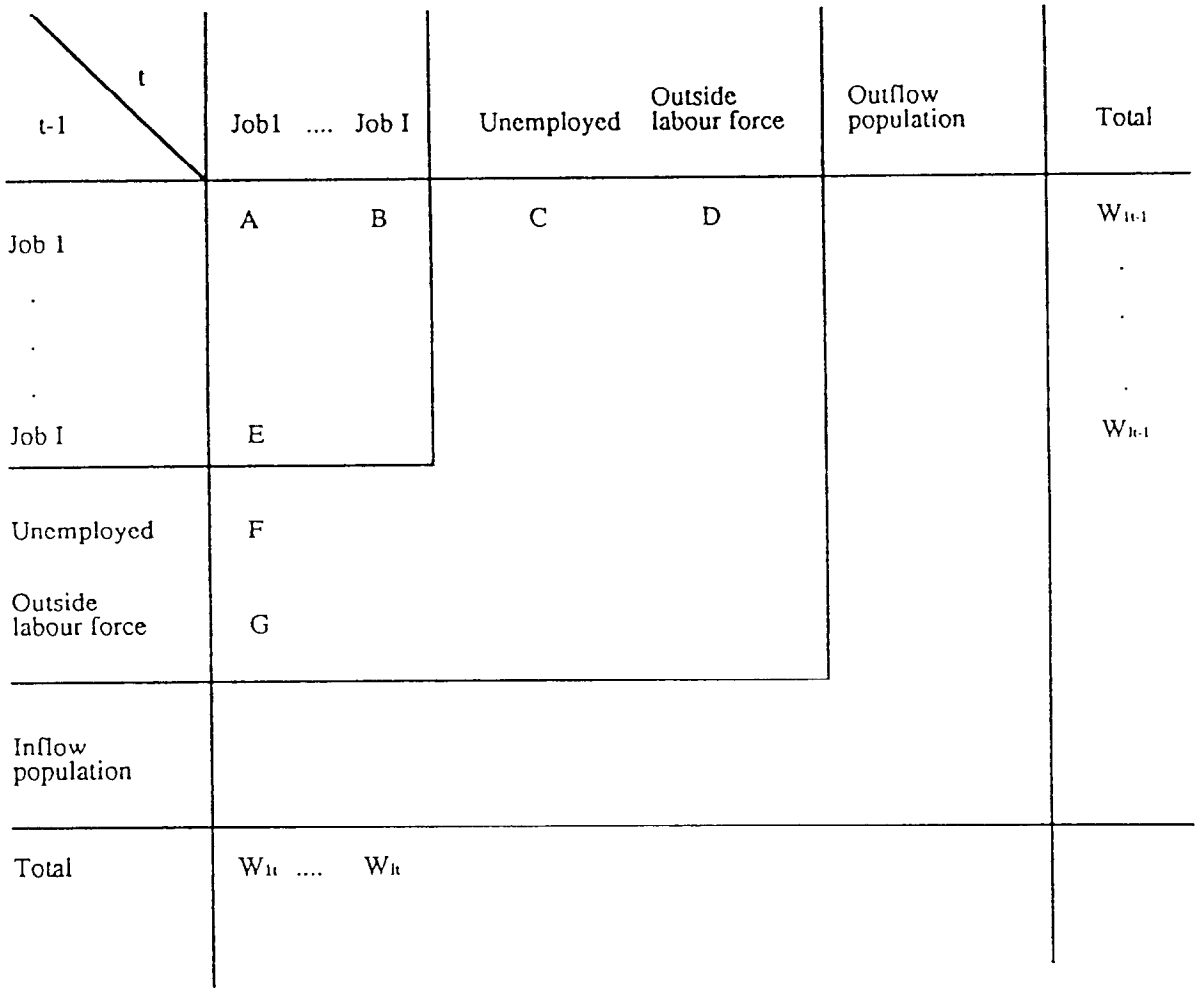

Fig. 1. Transition matrix showing currents of mobility in the labour market.

that is, the total influx of labour to the job in question. The concept of replacement demand can be explained further using Fig. 1. If there is an increase in employment, the replacement demand for job 1 is equal to the sum of flows B, C and D (the total outflow). However, if employment in job 1 decreases, the sum of flows E, F and G (the total inflow) gives the replacement demand.

3. Replacement demand by occupational class

3.1. Data and method

Section 2 discussed the method of determining theoretical replacement requirements in the past, assuming the availability of individual data on the mobility processes in the labour market. As the aim of this study is to determine the replacement demand for about 80 occupational classes and 50 types of education, it is not possible to base the analysis on the available individual data. Therefore, the aggregated data from the Labour Force Survey of the Central Bureau for Statistics (CBS) has to be used, and a method to determine the replacement demand based on this aggregated data has to be developed.

With the aid of a number of selection variables we can try to group the aggregated data so that most of the mobility flows specified in Fig. 1 can be observed. Variables that could be used include personal characteristics, such as sex, age and educational background. Because a large

number of cells are not well filled, however, the data is only divided according to age and sex. This is expected to be sufficient to detect most of the mobility processes. After all, the flow into a certain occupational group consists mostly of young people, while the flow out consists mostly of older employees. By making a distinction according to sex, the exit and re-entrance (temporary or not) of women is also captured to a significant extent.

In the remainder of this section we briefly discuss the data used and then explain, with the aid of a mathematical model, how the replacement demand by occupational group can be determined.

Data

The data from the Labour Force Survey of the CBS gives the age structure by sex and occupational class for the years 1979 and 1985.[3] The workers in each occupational class are divided by sex and age into 11 age groups, each age-band covering 5 years.

Method

The following variables are defined:

W_{ijt} = the number of workers in occupational class i of the age-band j at time t;
S_{ijt} = the number of workers in occupational class i of age j at time $t-1$ who are still working in this occupational class at time t (flow A in Fig. 1);
O_{ijt} = the flow of workers of age j at time $t-1$ out of occupational class i during the period $(t-1, t)$ (flows B, C and D in Fig. 1);
I_{ijt} = the flow of workers of age j at time t into occupational class i during the period $(t-1, t)$ (flows E, F and G in Fig. 1).

To avoid complicating the explanation unnecessarily, some simplifying assumptions are made in the presentation of the equations:[4]

- only three age groups are distinguished ($j = 1 \ldots 3$);
- the width of the age groups is the same as the length of the period $(t-1, t)$;
- the selection variable 'sex' is left out;
- the index i for the occupational classes which are distinguished is also omitted.

The model can be written to determine the replacement demand in the period $(t-1, t)$.

$$W_{1t-1} \equiv S_{1t} + O_{1t} \tag{2}$$

$$W_{2t-1} \equiv S_{2t} + O_{2t} \tag{3}$$

$$W_{3t-1} \equiv O_{3t} \tag{4}$$

$$W_{1t} \equiv I_{1t} \tag{5}$$

$$W_{2t} \equiv S_{1t} + I_{2t} \tag{6}$$

$$W_{3t} \equiv S_{2t} + I_{3t}\,. \tag{7}$$

In Eqs. (2) and (3) we see that some of those of a given age group who were working at time $t-1$ (W_{jt-1}) do not change their occupational group and are therefore still in the same occupational class at time t. In the equations this is marked by S_{jt}. Another group does change occupation or retires from the labour market. This is indicated by O_{jt}. The oldest group of workers at time $t-1$ (W_{3t-1}) will reach pensionable age in the period $(t-1, t)$ and will leave the work force altogether. This is given by Eq. (4).

Equation (5) says that the youngest group of workers in this occupational class at time t consists entirely of new arrivals to the labour market (school leavers). They have entered in the period $(t-1, t)$ (I_{1t}). Equation (6) shows that the group of working people in the second age-group includes those employees who have not been mobile in the period $(t-1, t)$, plus those newly entering the work force. These groups of workers are designated by S_{1t} and I_{2t}, respectively. The variable S has the age index 1, since these workers belonged to this age category at time t. Equation (7) is analogous to Eq. (6).

It should be noted that, for a given age category, only the net effect of the flows can be observed, since it is possible that part of the outflow is compensated for by an inflow of workers of the same sex and the same age category.

[3] See respectively CBS (1982, p. 126, table 30), and CBS (1987, p. 99, table 26). The occupational classification used corresponds to the International Standard Classification of Occupations (ISCO).

[4] These simplified assumptions were not made in the model used in the analysis itself.

The flows observed may therefore be described as the *net outflow* and the *net inflow*. This means that no empirical distinction can be made between I_{2t} and O_{1t} and between I_{3t} and O_{2t}. The *net outflow* for age categories 1 and 2 can be defined as

$$O^*_{1t} = \max\{0; W_{1t-1} - W_{2t}\} \tag{8}$$

$$O^*_{2t} = \max\{0; W_{2t-1} - W_{3t}\} \tag{9}$$

and, by analogy, the *net inflow* for the age groups 2 and 3 is

$$I^*_{2t} = \max\{0; W_{2t} - W_{1t-1}\} \tag{10}$$

$$I^*_{3t} = \max\{0; W_{3t} - W_{2t-1}\}\,, \tag{11}$$

where O^*_{jt} is the net outflow of workers of age j at time $t-1$ in the period $(t-1, t)$; I^*_{jt} is the net inflow of workers at age j at time t in the period $(t-1, t)$.

We have seen in Section 2 that the total replacement demand for an occupational class with rising employment equals the total flow of workers out, and that the replacement demand equals the total flow of workers in if the employment level is falling. If the concepts of inflow and outflow are interpreted as net inflow and outflow, replacement demand may be calculated as indicated in Eqs. (12) and (13):

$$W_t = \sum_j W_{jt} \geq \sum_j W_{jt-1} = W_{t-1} \Rightarrow$$

$$RD_t = O^*_{1t} + O^*_{2t} + O_{3t} \tag{12}$$

$$W_t = \sum_j W_{jt} < \sum_j W_{jt-1} = W_{t-1} \Rightarrow$$

$$RD_t = I_{1t} + I^*_{2t} + I^*_{3t} \tag{13}$$

where

RD_t is replacement demand for an occupational class in the period $(t-1, t)$.

3.2. The historical replacement requirement: A stylized example

The method developed in Section 3.1 to determine the replacement demand by occupational class will be further explained in this section by means of a simple example. Table 1 categorizes the workers of two occupational classes at times $t-1$ and t by age.

Table 1
Division of employment for two occupational groups into age categories (example).

Age group	Occupational group 1		Occupational group 2	
	$t-1$	t	$t-1$	t
1	150	160	280	275
2	200	220	130	100
3	50	35	40	50
Total	400	415	450	425

In this example, occupational class 1 is a growth occupation – the total employment has increased during the period $(t-1, t)$ – and occupational group 2 is shrinking. The expansion demand over this period is +15 and −25 for the two classes, respectively.

The historical replacement requirement can be determined by means of Eqs. (8)–(13). For occupational class 1 the replacement demand is 215. The replacement demand for occupational class 2 in period $(t-1, t)$ is 275. The net inflow is by definition equal to the sum of the net outflow and the expansion demand. The replacement demand for a declining class can therefore also be determined according to Eq. (14)

$$RD_t = O^*_{1t} + O^*_{2t} + O_{3t} + \left(\sum_j W_{jt} - \sum_j W_{jt-1}\right) \tag{14}$$

3.3. A forecasting method for future replacement demand

The replacement requirement for a certain occupational class will generally differ in each period. Thus the replacement demand for a relatively young occupational class (automation experts, for instance) may be historically have been low. Over time, however, the replacement demand will probably rise because the average age in this occupational class will rise. The replacement demand for an occupational class can also depend on several external factors, such as trade cycles or changes in the participation rate of the potential labour force. In making forecasts, these effects must be taken into consideration.

To simplify the matter, let us assume that the occupational class for which the future replacement demand has to be determined is a growth group.[5] The future replacement requirement, therefore, equals the sum of the expected outflows for all age groups from this occupational class.

The observed net inflow and outflow figures can be converted to yearly ratios for the various age categories of the occupational class in question.[6] If the duration of the period $(t-1, t)$ is D_1 years, then

$$gW_{jt} = \sqrt[D_1]{\frac{W_{j+1t}}{W_{jt-1}}} - 1 , \tag{15}$$

where gW_{jt} is the average yearly net inflow or outflow ratio of workers of age j at time $t-1$ from a certain occupational class during period $(t-1, t)$. For net outflow for a certain age category from an occupational class, $gW_{jt} < 0$; and for a net inflow, $gW_{jt} > 0$.

Correction for trade cycles

If economic activity is at a low point in the cycle, the flow of those who had been working in the occupational class in question into unemployment or out of the labour force will be relatively large. If one supposes that the business cycle manifests itself to the same degree in all occupational classes, then the measured net outflow ratio for every class will be influenced by the economic recession: this ratio will therefore be overestimated, from a structural point of view. In order to make the forecast of the future replacement demand 'cyclically neutral', the outflow ratio has to be corrected. The correction factor is the difference between the change in the total number of working persons and the change in the total labour force. The cyclical correction differs for each age category, to allow for the fact that the effects of the economic cycle are usually not the same for all age classes.

[5] The replacement demand for declining classes will be considered later in this section.

[6] The specification of annual ratios appears to be useful in relation to the corrections for trade cycle effect and degree of participation which will be dealt with below, and in relation to a possible difference in length between the period of observation and the period of the forecast.

Define

$$gWP_{jt} = \sqrt[D_1]{\frac{WP_{j+1t}}{W_{jt-1}}} - 1 , \tag{16}$$

$$gLF_{jt} = \sqrt[D_1]{\frac{LF_{j+1t}}{LF_{jt-1}}} - 1 , \tag{17}$$

where gWP_{jt} is the average yearly growth ratio of the total number of working persons of age j at time $t-1$ during the period $(t-1, t)$; gLF_{jt} is the average yearly growth ratio of the total labour force of age j at time $t-1$ during the period $(t-1, t)$; WP_{jt} is the total number of working persons of age j working at time t; LF_{jt} is the total labour force of age j at time t.

The data on the number of working persons are taken from the Labour Force Survey of the CBS and the data on the size of the labour force come from Op de Beke (1987). The total number of working persons for each age category equals the sum of the number of workers in all the occupational classes

$$WP_{jt} = \sum_i W_{ijt} . \tag{18}$$

To determine the future outflow figures, the measured net outflow figures per occupational class are corrected for cyclical influences. The future net outflow is lower if there has been an economic recession during the period of observation; that is, if the labour force has grown faster than the number of working persons. The correction can therefore be written as:

$$-gWP_{jt} + gLF_{jt} . \tag{19}$$

Correction for the degree of participation

Changes in the age structure of a certain occupational class are also dependent on changes in the degree of labour force participation of the different age groups. Obviously this effect should also be included in the modelling of the future replacement requirement.

The applied correction for the degree of participation is

$$-gLF_{jt} + gLF_{jt+1} . \tag{20}$$

In Eq. (20), gLF_{jt} represents the change in the

participation of the potential labour force of age j at time $t-1$, during the period $(t-1, t)$, and gLF_{jt+1} is the expected change in the participation of the labour force of this age during the period $(t, t+1)$. The difference between the two terms gives the effect of the expected change in the participation rate of the potential labour force on the outflow of workers. If the participation degree of a certain age category is expected to decrease in the future, the correction factor presented above is positive, and the net outflow of workers of that age is higher than in the historical period.

If the outflow for a certain age group in the past has been 0% or 100% ($gW_{jt} \geq 0$, $gW_{jt} = -1$, respectively), the same ratio may be assumed for the future. If the cyclical correction and the participation degree correction are combined, the (corrected) future outflow ratio by age categories ($g\hat{W}^*_{jt+1}$) are

$$g\hat{W}^*_{jt+1} = gW^*_{jt} - gWP_{jt} + gLF_{jt} - gLF_{jt} + gLF_{jt+1}$$
$$= gW^*_{jt} - gWP_{jt} + gLF_{jt+1} \quad \text{if } -1 < gW^*_{jt} < 0$$
$$g\hat{W}^*_{jt+1} = gW^*_{jt} \quad \text{otherwise} \qquad (21)$$

where gW^*_{jt+1} is the expected average yearly net inflow or outflow ratio of workers of age j at time t during the forecast period $(t, t+1)$.

With the aid of this expected future outflow ratio, we can forecast the future net outflow per occupational class [see Eqs. (8) and (9)]

$$\hat{O}^*_{jt+1} \max\{0, (W_{jt} - W_{jt}(1 + g\hat{W}^*_{jt+1})^{D_2})\}, \qquad (22)$$

where $\hat{O}^*_{jt+1}$ is the expected net outflow of workers of age j at time t during the forecast period $(t, t+1)$; D_2 is the duration of the forecast period.

If employment in an occupational class has risen in the period $(t-1, t)$, the sum of the expected net outflows for the age categories will forecast the future replacement demand in the occupational class in question. If the level of employment has fallen during the period, however, the replacement demand is equal to the total net inflow. As the future inflow according to age and sex is not known, the expected replacement demand in this case has to be determined by the net outflow, corrected for the negative change in the level of employment [see also Eq. (14)]

$$RD_{t+1} = \sum_j \hat{O}^*_{jt+1} + \left(\sum_j \hat{W}_{jt+1} - \sum_j W_{jt}\right) \qquad (23)$$

with

$$\sum_j \hat{W}_{jt+1} = \left(\sum_j W_{jt}\right)(gW_t - gWP_t + gLF_{t+1}), \qquad (24)$$

where $\Sigma_j \hat{W}_{jt+1}$ is an implied forecast of the number of workers in this occupational class at time $t+1$; gW_t is the average yearly growth ratio of employment in the occupational class in question during the period $(t-1, t)$; gWP_t is the average yearly growth ratio of the total number of working persons during the period $(t-1, t)$; gLF_{t+1} is the expected average yearly growth ratio of the total labour force during the period $(t, t+1)$.

Equation (23) shows that the expected future replacement demand is the sum of the expected net outflow and negative future changes in the level of employment. Note that the 'forecast' for future employment per occupational group is based on an extrapolation model, corrected for the cyclical and demographic developments – not based on employment forecasts using the occupational model [see Eq. (24)]. As the expected outflow figures are determined with this extrapolation method as well, this gives a consistent 'correction' for future changes in the level of employment.

3.4. The forecast results

The expected future replacement requirement can be determined using the forecasting method that has been developed in this section employing data on the age structure of workers for the years 1979 and 1985, by occupational classes. On this basis we have made forecasts for the period 1989–1994.[7]

[7] There is no detailed data available for the year 1989. Because the expansion demand forecasts [see Beekman et al. (1991)] refer to the period 1989–1994, replacement demand forecasts also refer to this period. This means that first an implicit forecast has been made for the replacement demand in the period 1985–1989.

The average replacement demand per occupational class in the period 1989–1994 is around 12% of the number employed in 1989, varying from 22% for professional soldiers and fishermen, hunters and related workers, to 2% for government executive officials and statisticians, system analysts and related workers. Because the amount of data involved is massive, a complete review of the comparative forecasts of replacement demand by occupational group is given in Appendix A[8]. A comparative qualitative characterization has been assigned to the replacement demand percentages for each occupational class [see Wieling et al. (1990)]. The replacement demand and the expansion demand together comprise the number of job openings in the period 1989–1994, which is an indication of the likelihood of finding a job in a certain occupational class during the forecast period. For 66 out of the 77 occupational classes distinguished, however, the replacement demand is the most important element of the total expected number of job openings.

4. Replacement demand by educational type

The replacement demand by type of education, like the demand by occupational classes, can be determined. The two concepts must, however, be interpreted differently. As noted in Section 3, the replacement demand per occupational class and the expansion demand together indicate how easily newcomers on the labour market may find a job in a particular occupational class. The net mobility between occupational classes is therefore taken into account: when an employee leaves for another occupational class, there is a replacement demand in the occupational class he or she has left. When determining the replacement demand per type of education, however, this occupational mobility is not taken into account. When an employee with a certain educational background changes occupational classes, this does not, on balance, create a new job for a newcomer with the same educational background. The replacement demand for a certain occupational class that is created by this occupational mobility is balanced by an equal flow of labour into another occupational class.

There is another difference between the replacement demand by occupational class and by type of education. If someone leaves a certain occupational class and is replaced by an employee with another (e.g. higher) educational background, there is a replacement demand for that occupational class. When such displacement or substitution effects occur, however, there is no replacement demand for the training types in question, but rather a negative expansion demand for one class and a positive expansion demand for the other [see Beekman et al. (1991)].

For the rest, the method for determining the replacement demand by type of education is analogous to the method explained in Section 3, substituting 'educational type' for 'occupational class'. The data required are the number of workers for each educational type, differentiated according to age and sex. Unfortunately, the Dutch Labour Force Surveys do not provide this data. Only the data matrices of the number of workers per occupational class according to age and sex and the number of workers per occupational class according to type of education are available. With the aid of these two matrices, a conversion is made to create a matrix of the number of working persons by type of education and according to age and sex. This can serve as a reasonably acceptable approximation of the actual data.[9]

This method, however, does not give plausible forecast results for some educational types held predominantly by women. For these types

[8] No forecasts of the future replacement demand for the occupational classes 'mining, quarrymen, well drillers, etc.', 'jewellery and precious metal workers', and 'operators of RTV, emission, sound and vision equipment' are given. The results for these occupational classes may be distorted because so many cells are empty or nearly so.

[9] The educational categories match closely the International Standard Classification of Education (ISCED).

of education, the fact that only the net outflow per age category is measured has a large effect. With a substantial re-entry of women, the net outflow for these types of education apparently differs to an important degree from the real outflow in the age group in question. The outflow figures for these types of education have been corrected on the basis of the differences in the degree of participation between age categories.[10] In this way the outflow (in the younger age groups in particular) can be better measured.

The average forecast replacement demand per educational type in the period 1989–1994 is around 8% of the number of workers in 1989. This percentage is lower than the average replacement demand per occupational class because, as already mentioned, the aspect of occupational mobility is not taken into account, and because part of the replacement demand in an occupational class, as a result of displacement or substitution processes within the educational group concerned, is measured as expansion demand. The forecast replacement demand is highest for those with intermediate education in social care (18%). The lowest expected replacement demand is for those with security education at a lower educational level (3%). A review of the replacement requirement per educational type can be found in Appendix B.[11]

5. Conclusion

This study develops a method of determining replacement demand by occupational class and educational type. The replacement demand per occupational group gives the extent of the withdrawal of working people from a certain occupational group. A distinction can be made between permanent departures (relating to retirement, etc.) and mobility to other occupational classes. The replacement demand by educational type does not take this last aspect into account and therefore is lower than the replacement demand by occupational class. The average expected replacement demand per occupational group for the period 1989–1994 is around 12% of the number of workers in 1989. For educational types, an average replacement demand of around 8% is expected.

It is important to note that any structural changes in the employment level by occupational class or educational type (e.g. owing to processes of substitution) are defined as a positive or negative *expansion demand* [see Dekker et al. (1990); Beekman et al. (1991)]. Therefore, these changes do not effect the replacement demand. This means that replacement demand forecasts are not an alternative to traditional manpower forecasts, but rather an often neglected, very important complement to these expansion demand forecasts. Taken together, replacement demand and expansion demand express the future number of *job openings* for newcomers on the labour market.

Further improvements in the method of forecasting future replacement demand are desirable. In particular, there is a need for better data to determine the replacement demand per educational type. Moreover, *flow* data of the various mobility processes on the labour market could improve the method of determining the replacement demand and enables us to measure directly the reentrance of women and the influx from unemployment or from other occupational classes.

[10] This correction was applied to those educational types for which two thirds or more of those working were women. When determining the replacement demand per occupational group, no such correction was made because the concept of degree of participation is defined per educational type and not per occupational group.

[11] For three educational types (lower vocational education nursing and medical services, higher vocational education dietics and nutrition, and academic education armed forces) no forecasts for the future replacement demand have been given. The results for these educational types may be significantly distorted because many cells are empty or nearly so.

Appendix A: Results replacement demand by occupational group

Table A.1. Replacement demand per occupational group 1989–1994

Occupational group	Replacement demand (%)
Relatively very high[a]	
Professional soldiers	22
Fishermen, hunters and related workers	22
Farm managers and supervisors	21
Metal processors	20
Telephone and telegraph operators	20
Relatively high[a]	
Workers in religion	19
Salesmen, shop assistants and related workers	19
Agricultural workers	18
Secretaries, typists and related workers	18
Launderers, dry-cleaners and pressers	18
Sales supervisors and buyers	17
Production supervisors and general foremen	17
Housekeeping and related service supervisors	16
Rubber and plastic product makers	16
Physical scientists and related technicians	16
Food and beverage processors	16
Average[a]	
Maids and related housekeeping workers	15
Working proprietors (catering and lodging services)	15
Professional sportsmen and related workers	14
Computing machine operators	14
Service workers n.e.c.	14
Printers and related workers	14
Hairdressers, barbers, beauticians and related workers	14
Cooks, waiters, bartenders and related workers	14
Machinery fitters, machine assemblers and related workers	14
Shoemakers and leather goods makers	14
Blacksmiths, toolmakers and machine tool operators	14
Insurance, real estate securities and business services, salesman and auctioneers	14
Aircraft and ship's officers	14
Bookkeepers, cashiers and related workers	13
Transport equipment operators	13
Stationary engine and related equipment operators	13
Farmers	13
Sculptors, painters, photographers and related creative artists	12
Clerical and related n.e.c.	12
Electrical fitters and related electric and electronic workers	12
Wood preparation workers and paper makers	12
Material handling and related equipment operators, dockers and freight handlers	12
Transport and communications supervisors	12
Plumbers, welders sheet metal and structural preparers and erectors	11
Chemical processors and related workers	11
Managers (catering and lodging services)	11
Legislative officials and government administrators	11
Paper and paperboard product makers	11
Accountants	10
Economists	10
Glass formers, potters and related workers	10
Building caretakers, cleaners and related workers	10
Spinners, weavers, knitters, dyers and related workers	10
Technical salesmen, commercial travellers and manufacturer's agents	10

Table A.1. (Continued)

Occupational group	Replacement demand (%)
Relatively low[a]	
Life scientists and related technicians	9
Managers (retail trade)	9
Tailors, dressmakers and related workers	9
Managing and higher executive functions exclusive of public administration	9
Composers and performing artists	9
Architects, engineers and related technicians	8
Medical, dental, veterinary and related workers	8
Jurists	8
Teachers	8
Clerical supervisors	8
Bricklayers, carpenters and other construction workers	8
Professional, technical and related workers	8
Working proprietors (wholesale)	8
Protective service workers	7
Transport conductors	7
Managers (wholesale)	7
Painters	7
Shopkeepers, streetvendors	7
Production and related workers	6
Forestry workers	6
Mail distribution clerks	6
Relatively very low[a]	
Labourers n.e.c.	5
Authors, journalists and related workers	4
Cabinetmakers, woodworkers and related workers	4
Tobacco preparers and tobacco product makers	4
Statisticians, system analysts and related workers	2
Government executive officials	2

Source: ROA.

[a] The qualifications are based on the average and variance of the results for the different occupational classes [see Wieling et al. (1990)].

Appendix B: Results replacement demand by educational type

Table B.1. Replacement demand per educational type 1989–1994

Educational type	Replacement demand (%)
Relatively very high[a]	
Intermediate Vocational Education, Social Care	18
Lower Vocational Education, Social Care & Catering	15
Academic Education, Theology	15
Intermediate Vocational Education, Medical Services	14
Relatively high[a]	
Lower Vocational Education, Technical	12
Intermediate Vocational Education, Nursing	12
Lower Vocational Education, Economic & Administrative	11
Intermediate Vocational Education, Medical Laboratory	11
Higher Vocational Education, Theology	11

Table B.1. (Continued)

Educational type	Replacement demand (%)
Average[a]	
Lower General Secondary Education	10
Intermediate Vocational Education, Catering & Hairdressing	10
Lower Vocational Education, Transport & Harbour	9
Intermediate Vocational Education, Administration & Legal & Fiscal	9
Higher Vocational Education, Air force & Marine & Traffic	9
Higher Vocational Education, Medical Laboratory	9
Lower Vocational Education, Agriculture	8
Intermediate Vocational Education, Agriculture	8
Intermediate Vocational Education, Police & Fire Brigade & Defense	8
Intermediate Vocational Education, Technical & Laboratory	8
Higher Vocational Education, Teacher Training	8
Higher Vocational Education, Catering	8
Higher General Secondary Education	7
Intermediate Vocational Education, Social & Cultural	7
Intermediate Vocational Education, Transport & Harbour & Telecommunications	7
Higher Vocational Education, Agriculture	7
Higher Vocational Education, Administration & Legal & Fiscal	7
Higher Vocational Education, Art	7
Higher Vocational Education, Police & Fire Brigade & Defense	7
Academic Education, Mathematics & Natural Sciences	7
Relatively low[a]	
Primary Education	6
Higher Vocational Education, Social & Cultural	6
Higher Vocational Education, Technical	6
Academic Education, Agriculture	6
Academic Education, Economics & Business Administration	6
Academic Education, Law & Public Administration	6
Academic Education, Social Sciences	6
Academic Education, Technical Sciences	6
Intermediate Vocational Education, Economics & Administration	5
Higher Vocational Education, Business Administration Technology	5
Higher Vocational Education, Technical & Laboratory	5
Higher Vocational Education, Interpreter & Translator	5
Academic Education, Fine Arts	5
Academic Education, Literature & History, etc.	5
Relatively very low[a]	
Intermediate Vocational Education, Sports Teacher & Recreation	4
Higher Vocational Education, Economic & Administrative	4
Higher Vocational Education, Nursing & Physiotherapy, etc.	4
Academic Education, Veterinary, Medical Science & Dentistry	4
Academic Education, Teacher Training	4
Academic Education, Econometrics & Business Administration	4
Academic Education, Pharmacy	4
Lower Vocational Education, Security	3

Source: ROA

[a] The qualifications are based on the average and variance of the results for the different types of education [see Wieling et al. (1990)].

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